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MODIFIED RING COMPRESSION TESTS ON 42-LB. LINERBOARD

Project 1108-32 (*Report 1108*)

A Preliminary Report

to

TECHNICAL COMMITTEE

OF THE

FOURDRINIER KRAFT BOARD INSTITUTE, INC.

November 15, 1963

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MODIFIED RING COMPRESSION TESTS ON 42-LB. LINERBOARD

INTRODUCTION

As requested by the Technical Committee, modified ring compression tests are currently being made on all samples of 42-lb. linerboard received in connection with Project 1108-13, the base-line study on 42-lb. linerboard. This testing program was initiated on the samples of linerboard received during July. The first report presented a bimonthly summation of the results obtained during July and August. The current report—the second in this series—presents a bimonthly summation of the results obtained during September and October.

PROCEDURE

The procedure followed in evaluating each sample of linerboard for modified ring compression strength has involved a number of steps which are described subsequently in this paragraph in the order of their performance. The twenty-four 14 by 14-inch sheets comprising each sample of linerboard submitted for evaluation in connection with the base-line study on 42-lb. linerboard (Project 1108-13) were first preconditioned for at least 24 hours at 73°F. and less than 35% R.H. and then conditioned for at least 48 hours at 73°F. and 50% R.H., the latter atmosphere also being the environment in which subsequent specimen preparation and testing were carried out. Twelve of the twenty-four 14 by 14-inch sheets in each sample were next trimmed to 12 by 12 inches preparatory to the determination of basis weight and caliper for Project 1108-13. After basis weight and caliper had been determined, specimens were cut for modified ring compression tests, one machine direction specimen and one cross-machine direction specimen being cut from each of five of the 12 by 12-inch sheets (randomly

selected) to give a total of five specimens in each direction. Each specimen was die cut (using a Concora specimen cutter) to a 0.5 by 6-inch size with the 0.5-inch dimension parallel to the specified orientation, i.e., machine direction or cross-machine direction. The loading edges of each specimen were next touched against a sheet of wax-saturated paper toweling lying on a hot plate set at 170 to 175°F. (Mobilwax D was used to saturate the paper toweling). The loading edges of each specimen were held in contact with the paper toweling long enough to permit the wax to migrate into the specimen to a depth of approximately 1/16 inch. The next step involved applying a 3/16 to 1/4-inch wide strip of Weldwood contact cement by means of a brush to each end of the specimen to permit overlapping and adhering the ends together. Prior to this, however, the contact cement was given time to become visibly dry so that when the ends were overlapped and joined, their bonding was immediate and secure. The overlapping and joining of the ends of each specimen was accomplished by wrapping the specimen around a Plexiglas cylinder having a height of 1/2 inch and a diameter of 1.840 inches. This cylinder dimension limited the overlapping of the ends to a minimum of 1/8 inch and maximum of 3/16 inch. The Plexiglas cylinder was also helpful in achieving parallel loading edges. For each group of five specimens for machine direction tests and for each group of five specimens for cross-machine direction tests, two specimens were formed with the best side contacting the Plexiglas and three were formed with the wire side contacting the Plexiglas.

Each specimen, after being prepared as described above, was conditioned in the test atmosphere for at least 12 hours and then tested using the conventional ring holder (ASTM) but substituting a 1/4-inch high Plexiglas cylinder (of the same diameter as the cylinder on which the specimens were formed) for the

conventional island. The testing was carried out on an H. and D. compression tester at a loading rate of approximately 900 lb./min. measured with the platens in contact with each other. The modified ring compression strength was recorded to the nearest pound for each specimen and then converted to a unit width basis (lb./in.) by dividing the maximum load sustained by the specimen length which was six inches.

RESULTS

During September and October, 135 sample lots of 42-lb. linerboard were evaluated by means of the modified ring compression test. The results obtained for the individual mills are given in Tables I to XXIII for Mills A to X, respectively. (The code letters used in this report do not correspond to any used previously for any project.) It may be noted from the results for each mill given in Tables I to XXIII that, in addition to data for each sample lot, composite averages of the machine direction and cross-machine direction data (referred to in the tables as "current mill averages") are also given, having been obtained by calculating the arithmetic means of the machine direction and cross-machine direction averages for the individual sample lots. In Table XXIV the current mill averages and number of sample lots evaluated from each mill are summarized, the means of the current mill averages for machine direction and cross-machine direction modified ring compression are also shown in Table XXIV and are referred to as "current F.K.I. averages." The data given in Table XXIV are presented graphically in Fig. 1.

TABLE I

SUMMARY OF DATA FOR MILL A

September and October, 1963

Code	Date Made	Finish	Mch. No.	Modified Ring Compression, lb./inch					
				In Machine			Cross Machine		
				Max.	Min.	Av.	Max.	Min.	Av.
A-1	8-25-63	W.B.	-	22.8	21.0	22.1	17.8	16.2	17.2
A-2	9- 4-63	W.B.	-	23.3	21.5	22.5	18.5	16.8	17.9
A-3	9- 5-63	W.B.	-	22.7	20.8	21.7	17.8	16.7	17.2
A-4	10- 9-63	W.B.	-	22.7	20.7	21.7	16.7	15.8	16.2
A-5	9-23-63	W.B.	-	21.7	18.3	19.7	16.7	15.0	15.7
A-6	10- 9-63	W.B.	-	23.3	20.3	21.8	17.5	15.8	16.6
Current mill average:						21.6			16.8

TABLE II

SUMMARY OF DATA FOR MILL B

B-1	8-14-63	W.F.	1	23.3	21.2	22.2	18.3	15.8	17.2
B-2	8-20-63	W.F.	1	23.8	22.0	23.1	19.8	18.7	19.3
B-3	8-28-63	W.F.	1	24.2	22.3	23.5	19.5	18.5	19.0
B-4	9- 5-63	W.F.	1	22.7	21.5	22.0	17.5	16.7	17.2
B-5	9-13-63	W.F.	1	23.0	21.3	22.1	18.7	17.3	18.1
B-6	9-19-63	W.F.	1	22.5	20.7	21.7	18.0	16.8	17.5
B-7	9-27-63	W.F.	1	20.8	18.7	19.6	16.3	14.7	15.1
B-8	10- 3-63	W.F.	1	21.7	20.7	21.2	17.2	16.0	16.4
Current mill average:						21.9			17.5

TABLE III

SUMMARY OF DATA FOR MILL C

September and October, 1963

Code	Date Made	Finish	Mch. No.	Modified Ring Compression, lb./inch					
				In Machine			Cross Machine		
				Max.	Min.	Av.	Max.	Min.	Av.
C-1	9-17-63	----	2	23.0	21.5	22.3	16.7	15.0	15.6
C-2	9-18-63	----	2	23.5	21.5	22.4	16.7	15.5	16.0
C-3	9-13-63	----	1	22.3	20.5	21.1	17.5	17.2	17.3
C-4	9-26-63	----	1	22.5	20.8	21.6	16.3	15.0	15.6
C-5	10- 3-63	----	2	22.7	19.5	21.5	16.0	14.7	15.3
C-6	10- 4-63	----	2	21.3	20.2	20.7	16.5	13.2	15.3
C-7	10- 4-63	----	1	21.5	20.7	21.2	17.3	15.8	16.6
Current mill average:						21.5			16.0

TABLE IV

SUMMARY OF DATA FOR MILL D

D-1	7-22-63	W.F.	2	24.2	21.7	23.2	19.0	17.0	17.7
D-2	7-22-63	W.F.	2	22.5	20.0	21.3	18.5	15.7	16.7
D-3	8-19-63	W.F.	2	24.2	22.3	23.3	19.8	17.5	18.5
D-4	8-19-63	W.F.	2	23.3	21.7	22.5	21.0	16.7	18.8
D-5	9-12-63	W.F.	2	23.7	21.7	22.8	18.3	16.7	17.4
D-6	9-12-63	W.F.	2	22.5	20.7	21.7	16.8	15.7	16.5
D-7	10- 1-63	W.F.	2	25.0	21.7	23.3	18.3	16.7	17.7
D-8	10- 1-63	W.F.	2	25.0	21.7	23.3	18.0	15.8	16.7
Current mill average:						22.7			17.5

TABLE V

SUMMARY OF DATA FOR MILL E

September and October, 1963

Code	Date Made	Finish	Mch. No.	Modified Ring Compression, lb./inch					
				In Machine			Cross Machine		
				Max.	Min.	Av.	Max.	Min.	Av.
E-1	8-17-63	WF1S	2	22.0	20.7	21.3	17.0	15.2	16.1
E-2	9- 7-63	WF1S	2	21.8	20.5	21.0	17.0	15.7	16.3
E-3	9- 9-63	WF1S	2	23.0	21.2	22.0	17.5	16.7	17.0
E-4	9-18-63	WF1S	2	21.0	18.7	19.5	15.5	14.8	15.1
E-5	9-20-63	WF1S	2	20.2	18.7	19.5	15.8	14.7	15.3
E-6	9-21-63	WF1S	2	20.8	19.2	20.0	15.7	15.0	15.3
Current mill average:						20.5			15.8

TABLE VI

SUMMARY OF DATA FOR MILL F

F-1	8- 1-63	W.F.	1	20.2	18.5	19.5	15.7	14.3	15.0
F-2	8- 3-63	W.F.	1	20.7	18.3	19.5	16.7	15.2	15.7
F-3	8-11-63	W.F.	1	21.2	19.7	20.5	16.0	15.0	15.5
F-4	8-14-63	W.F.	1	20.3	19.2	19.8	16.2	15.0	15.6
F-5	8-23-63	W.F.	1	22.3	20.5	21.5	16.8	16.3	16.5
F-6	8-26-63	W.F.	1	23.2	21.2	22.1	16.7	15.7	16.2
F-7	8-28-63	W.F.	1	22.3	21.3	21.7	18.2	16.3	17.0
F-8	8-31-63	W.F.	1	22.8	21.3	22.3	17.0	16.5	16.8
F-9	9- 4-63	W.F.	1	22.0	20.7	21.3	16.7	16.0	16.4
F-10	9- 8-63	W.F.	1	21.0	20.0	20.6	16.2	15.5	15.7
F-11	9-10-63	W.F.	1	22.5	21.3	21.9	18.0	16.5	17.3
F-12	9-13-63	W.F.	1	22.0	20.5	21.2	17.2	15.8	16.4
F-13	9-23-63	W.F.	1	21.7	18.8	20.0	17.0	13.8	15.4
F-14	9-26-63	W.F.	1	21.7	19.5	20.3	16.3	14.8	15.6
F-15	9-27-63	W.F.	1	21.7	20.2	20.9	16.2	14.7	15.5
F-16	9-29-63	W.F.	1	21.5	20.5	21.0	18.3	15.3	16.1
F-17	10- 4-63	W.F.	1	21.0	19.7	20.4	16.5	16.0	16.3
F-18	10- 6-63	W.F.	1	21.0	20.3	20.7	16.7	15.5	16.1
F-19	10-14-63	W.F.	1	21.2	20.2	20.7	17.3	16.7	17.0
F-20	10-15-63	W.F.	1	21.2	19.8	20.4	17.0	15.8	16.4
Current mill average:						20.8			16.1

TABLE VII
 SUMMARY OF DATA FOR MILL G
September and October, 1963

Code	Date Made	Finish	Mch. No.	Modified Ring Compression, lb./inch					
				In Machine			Cross Machine		
				Max.	Min.	Av.	Max.	Min.	Av.
G-1	8-15-63	----	1	22.0	20.7	21.3	16.7	15.2	16.0
G-2	8-16-63	----	1	21.8	20.7	21.2	16.3	15.0	15.8
G-3	9- 5-63	----	1	22.0	21.2	21.6	18.5	16.5	17.7
G-4	9- 9-63	----	1	22.8	20.7	21.8	17.2	16.3	16.8
G-5	9-26-63	----	1	22.5	20.0	21.4	16.2	13.5	15.2
G-6	10- 2-63	----	1	20.0	18.2	19.1	15.3	13.3	14.2
G-7	10- 9-63	----	1	20.0	18.7	19.3	15.8	13.7	14.7
Current mill average:						20.8			15.8

TABLE VIII
 SUMMARY OF DATA FOR MILL H

H-1	8-22-63	WF1S	1	24.3	22.0	23.4	19.2	17.2	18.0
H-2	8-29-63	WF1S	1	24.3	22.2	23.2	18.8	16.7	18.1
H-3	9- 4-63	WF1S	1	23.7	21.2	22.2	17.7	16.5	17.1
H-4	9-11-63	WF1S	1	24.5	23.0	23.8	19.2	17.0	18.1
H-5	9-17-63	WF1S	1	22.7	21.5	22.1	18.7	17.5	17.9
H-6	9-24-63	WF1S	1	23.7	22.7	23.1	18.3	16.0	17.7
H-7	10- 1-63	WF1S	1	23.5	22.3	22.9	18.7	15.0	16.7
H-8	10- 8-63	WF1S	1	22.2	19.3	20.9	17.5	15.8	16.8
H-9	10-15-63	WF1S	1	23.5	21.5	22.7	18.3	16.3	17.5
H-10	10-23-63	WF1S	1	24.0	21.8	22.7	17.7	16.0	17.1
Current mill average:						22.7			17.5

TABLE IX

SUMMARY OF DATA FOR MILL I

September and October, 1963

Code	Date Made	Finish	Mch. No.	Modified Ring Compression, lb./inch					
				In Machine			Cross Machine		
				Max.	Min.	Av.	Max.	Min.	Av.
I-1	8-26-63	WF1S	2	22.5	20.8	21.5	17.2	16.2	16.7
I-2	9- 3-63	WF1S	2	20.5	19.8	20.2	15.7	14.7	15.1
I-3	9- 9-63	WF1S	2	22.3	20.3	21.5	16.7	15.7	16.1
I-4	9-16-63	WF1S	2	22.0	21.0	21.7	17.7	16.2	16.8
I-5	10- 1-63	WF1S	2	20.3	18.3	19.3	17.3	14.7	15.6
I-6	10- 7-63	WF1S	2	21.3	20.3	20.8	15.3	14.7	15.0
Current mill average:						20.8			15.9

TABLE X

SUMMARY OF DATA FOR MILL J

No samples submitted.

TABLE XI

SUMMARY OF DATA FOR MILL K

K-1	8-24-63	WF1S	2	23.2	20.7	22.0	18.5	17.3	17.9
K-2	8-24-63	WF1S	2	22.8	21.7	22.1	19.3	16.8	18.1
K-3	9-20-63	W.F.	2	22.3	20.8	21.6	18.3	16.7	17.5
K-4	9-20-63	WF1S	2	22.2	21.2	21.7	18.2	16.3	17.3
K-5	10-17-63	W.F.	2	22.0	20.7	21.2	17.2	16.0	16.5
Current mill average:						21.7			17.4

TABLE XII

SUMMARY OF DATA FOR MILL L

September and October, 1963

Code	Date Made	Finish	Mch. No.	Modified Ring Compression, lb./inch					
				In Machine			Cross Machine		
				Max.	Min.	Av.	Max.	Min.	Av.
L-1	7-27-63	W.F.	1	20.7	19.5	19.9	16.8	15.3	16.1
L-2	8-19-63	W.F.	1	22.8	20.7	21.8	19.2	16.5	17.8
L-3	9- 4-63	W.F.	1	23.5	21.3	22.6	19.0	17.5	18.5
L-4	9-12-63	W.F.	1	22.5	21.3	22.0	19.0	16.5	18.0
L-5	10- 2-63	W.F.	1	22.3	21.5	21.9	17.8	16.8	17.4
Current mill average:						21.7			17.6

TABLE XIII

SUMMARY OF DATA FOR MILL M

M-1	8-18-63	W.B.	-	22.0	19.5	20.9	17.3	15.7	16.4
M-2	8-21-63	W.B.	-	21.7	20.7	21.1	17.3	15.5	16.9
M-3	8-22-63	W.B.	-	22.8	21.2	22.2	18.2	17.3	17.8
M-4	9- 5-63	W.B.	-	23.0	21.5	22.4	18.2	16.2	17.5
M-5	9- 6-63	W.B.	-	23.2	21.3	21.9	18.5	15.0	17.1
M-6	9- 7-63	W.B.	-	23.7	21.7	22.5	18.2	16.0	17.2
M-7	9-12-63	W.B.	-	22.7	20.8	21.9	18.8	16.7	17.8
M-8	10- 8-63	W.B.	-	21.7	20.0	21.0	17.5	16.7	17.0
Current mill average:						21.7			17.2

TABLE XIV

SUMMARY OF DATA FOR MILL N

N-1	9-11-63	WF1S	1	21.5	20.7	21.2	17.0	15.0	15.8
N-2	9-28-63	----	1	20.8	19.0	20.0	16.0	15.0	15.5
Current mill average:						20.6			15.6

TABLE XV

SUMMARY OF DATA FOR MILL O

September and October, 1963

Code	Date Made	Finish	Mch. No.	Modified Ring Compression, lb./inch					
				In Machine			Cross Machine		
				Max.	Min.	Av.	Max.	Min.	Av.
O-1	8-27-63	W.F.	3	24.0	22.7	23.2	18.3	17.2	17.8
O-2	8-29-63	W.F.	3	23.3	22.0	22.7	18.3	17.7	18.1
O-3	9- 6-63	W.F.	3	23.2	22.2	22.6	18.7	18.2	18.5
O-4	9- 8-63	W.F.	3	24.0	21.7	22.7	18.7	16.7	17.7
O-5	9-22-63	W.F.	3	26.7	20.0	22.0	16.0	15.2	15.6
O-6	9-29-63	W.F.	3	26.0	19.0	23.4	17.8	15.5	16.3
Current mill average:						22.8			17.3

TABLE XVI

SUMMARY OF DATA FOR MILL P

P-1	8-13-63	WF1S	1	24.5	22.8	23.7	19.2	16.8	18.1
P-2	8-22-63	WF1S	1	24.3	22.7	23.5	18.3	16.7	17.7
P-3	9- 8-63	WF1S	1	23.8	22.5	23.4	18.3	16.3	17.2
P-4	9- 9-63	WF1S	1	23.3	22.8	23.1	19.5	18.2	18.9
P-5	9-10-63	WF1S	1	24.7	20.8	22.6	18.3	16.2	17.5
P-6	9-19-63	WF1S	1	24.0	21.7	22.7	17.8	15.7	16.8
P-7	10-14-63	WF1S	1	26.3	21.7	23.9	18.2	16.0	17.3
P-8	10-16-63	WF1S	1	24.0	22.5	23.3	17.2	15.2	15.8
Current mill average:						23.3			17.4

TABLE XVII

SUMMARY OF DATA FOR MILL Q

September and October, 1963

Code	Date Made	Finish	Mch. No.	Modified Ring Compression, lb./inch					
				In Machine			Cross Machine		
				Max.	Min.	Av.	Max.	Min.	Av.
Q-1	8-17-63	W.F.	-	22.3	20.0	21.1	18.2	17.0	17.6
Q-2	8-17-63	W.F.	-	22.7	20.7	21.7	18.7	16.3	17.7
Q-3	9-20-63	W.F.	-	23.7	19.7	21.5	18.3	14.3	16.7
Q-4	9-20-63	W.F.	-	20.2	18.5	19.2	17.0	15.2	16.1
Current mill average:						20.9			17.0

TABLE XVIII

SUMMARY OF DATA FOR MILL S

No samples submitted.

TABLE XIX

SUMMARY OF DATA FOR MILL T

T-1	8-29-63	W.F.	-	24.0	23.3	23.6	19.2	17.8	18.6
T-2	8-30-63	W.F.	-	24.2	22.5	23.1	19.7	17.7	19.0
T-3	9-13-63	W.F.	-	23.2	22.0	22.6	19.0	16.8	18.0
T-4	9-20-63	W.F.	-	22.7	22.0	22.3	19.3	17.0	18.2
T-5	10- 3-63	W.F.	-	22.7	20.0	21.4	18.0	16.7	17.6
T-6	10- 4-63	W.F.	-	21.7	20.3	21.2	17.8	16.7	17.1
T-7	10-11-63	W.F.	-	21.7	20.7	21.2	17.7	15.2	16.9
T-8	10-18-63	W.F.	-	21.0	18.8	20.2	18.5	15.8	17.5
Current mill average:						22.0			17.9

TABLE XX

SUMMARY OF DATA FOR MILL U

September and October, 1963

Code	Date Made	Finish	Mch. No.	Modified Ring Compression, lb./inch			Cross Machine		
				Max.	Min.	Av.	Max.	Min.	Av.

No samples submitted.

TABLE XXI

SUMMARY OF DATA FOR MILL V

V-1	8-23-63	----	-	20.7	18.3	19.8	15.2	13.8	14.4
V-2	8-26-63	----	-	21.3	19.5	20.5	16.3	15.3	16.0
V-3	9-13-63	----	-	21.7	19.7	20.5	16.2	15.0	15.6
V-4	10- 9-63	----	-	20.3	19.2	19.6	15.2	14.3	14.7
Current mill average:						20.1			15.2

TABLE XXII

SUMMARY OF DATA FOR MILL W

W-1	8-15-63	WF1S	1	24.0	22.5	23.1	18.2	16.3	17.2
W-2	8-18-63	WF1S	1	23.7	22.5	23.2	18.0	17.3	17.8
W-3	9- 6-63	WF1S	1	24.2	23.0	23.5	19.0	17.3	18.2
W-4	9-15-63	WF1S	1	23.8	22.0	22.8	18.7	16.0	17.1
W-5	9-24-63	WF1S	1	22.8	21.0	21.7	17.8	16.0	16.8
W-6	10- 3-63	WF1S	1	24.0	22.0	23.0	18.7	15.0	16.9
W-7	10-10-63	WF1S	1	23.3	22.2	22.8	18.0	15.8	17.0
Current mill average:						22.9			17.3

TABLE XXIII

SUMMARY OF DATA FOR MILL X

No samples submitted.

TABLE XXIV
SUMMARY OF COMPOSITE MILL AVERAGES

September and October, 1963

Mill	Number of Samples	Modified Ring Compression, lb./inch	
		In Machine	Cross Machine
A	6	21.6	16.8
B	8	21.9	17.5
C	7	21.5	16.0
D	8	22.7	17.5
E	6	20.5	15.8
F	20	20.8	16.1
G	7	20.8	15.8
H	10	22.7	17.5
I	6	20.8	15.9
J	0	No samples submitted.	
K	5	21.7	17.4
L	5	21.7	17.6
M	8	21.7	17.2
N	2	20.6	15.6
O	6	22.8	17.3
P	8	23.3	17.4
Q	4	20.9	17.0
S	0	No samples submitted.	
T	8	22.0	17.9
U	0	No samples submitted.	
V	4	20.1	15.2
W	7	22.9	17.3
X	0	No samples submitted.	
Total:	135		
Current FKI average:		21.6	16.8

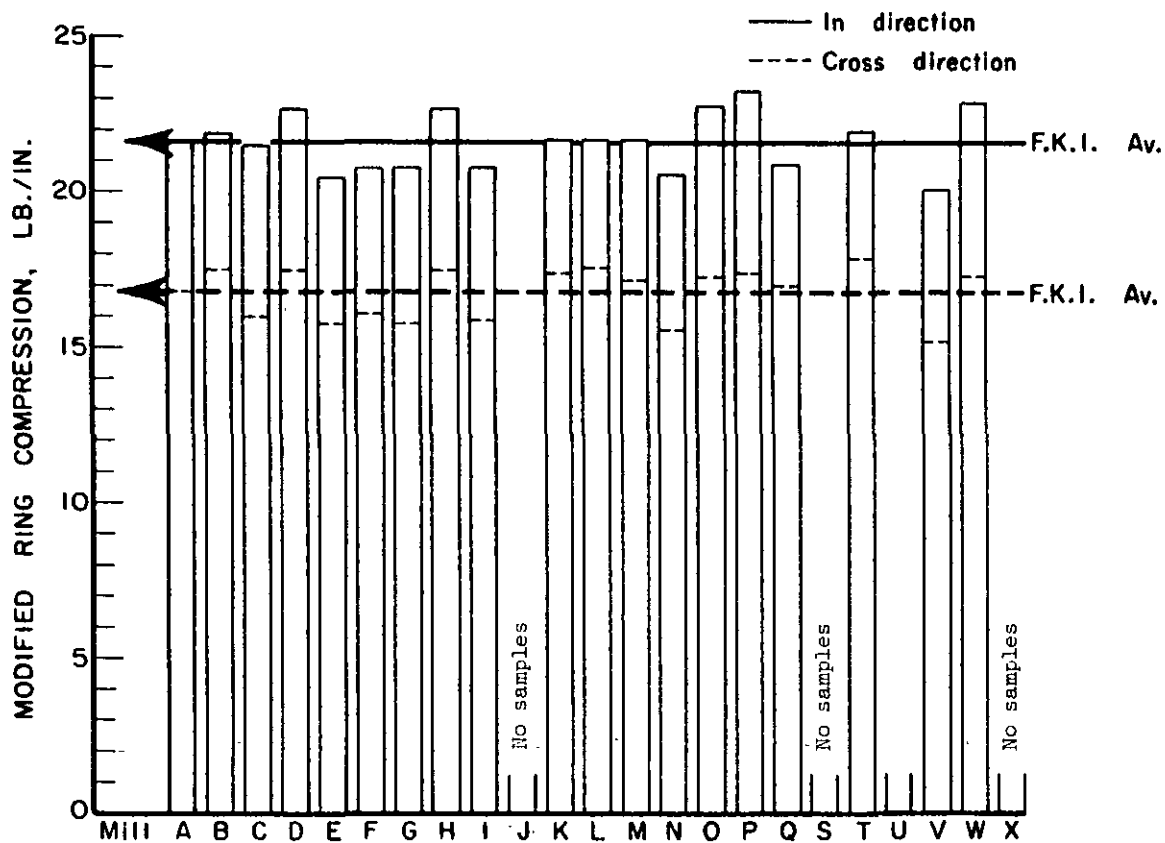


Figure 1. Comparison of Modified Ring Compression Results (In and Cross-Machine Directions)

